Wildfire Risk Assessment using PLS-CADD and LiDAR Surveys

Power Line Systems

Introduction

Utilities around the world have been using the Power Line Systems (PLS) suite of software for the design of overhead electric power transmission and distribution lines and their supporting structures for over 25 years. PLS-CADD has become the industry standard for the design and analysis of overhead power lines. Utilities and consultants are able to create sophisticated three-dimensional models of overhead lines which include detailed terrain data, complete structure models and accurate wire or catenary sags and tensions.

With the recent focus by utilities and regulators on the reliability and resiliency of the electric grid, organizations have been using the PLS software to evaluate existing overhead transmission and distribution lines and design new lines for the enhanced design standards. One area where PLS-CADD has provided to be incredibly valuable is in the area of vegetation management. Utilities have been using PLS-CADD, in conjunction with LiDAR (Light Detection and Ranging) surveys, to develop accurate models of the overhead lines and vegetation in and around the right-of-way which then can be used to determine clearances to trees and other vegetation under any weather scenario. However, using many of these same tools, utilities can also utilize PLS-CADD for the evaluation and mitigation of wildfire damage in and around their overhead lines.

Survey Data

Any evaluation of vegetation or other objects along or within the overhead line right-of-way starts with an accurate and up-to-date survey. LiDAR survey technology has been around for many years and has proven to the be the most accurate and cost-effective survey method for existing overhead lines. Because LiDAR surveys can be conducted from the air with airplanes, helicopters or even drones, collecting data for linear projects and in remote areas is often relatively simple.

Trees and vegetation are not the only areas of concern which can be identified by a LiDAR survey. Other objects such as large debris piles, adjacent or crossing electric lines, sheds, or other encroachments can easily be identified through a LiDAR survey. Many of these objects are potential hazards for a wildfire mitigation analysis.

LiDAR survey data can be enhanced with aerial photos and videos. Video cameras mounted to the aerial equipment can capture detailed images of the right-of-way during the data collection flights and these images can be used to help interpret the LiDAR data and identify potential wildfire risk areas.

Multispectral cameras can also be used to determine the health of trees and vegetation using the Normalized Difference Vegetation Index (Manyame and Jackson. “Flying High to Improve Vegetation Management”, T&D World Magazine, March 9, 2017). Analysis of the NDVI images can assist in the identification of unhealthy or dead vegetation without the need for field crews to walk the right-of-way.

Detection of Fire Risk Areas

One major benefit of a LiDAR survey is the collection of data on the exact location of structures and wires on the overhead lines. This data is vital to building an accurate model of the existing overhead line in PLS-CADD. Often times, detailed records of existing overhead lines may not exist or may be of poor or inconsistent quality and therefore not suitable for building an accurate model of the overhead line. The need for an accurate line model, particularly the location and sags of the wires, is critical to the clearance evaluation and detection of the fire risk areas.

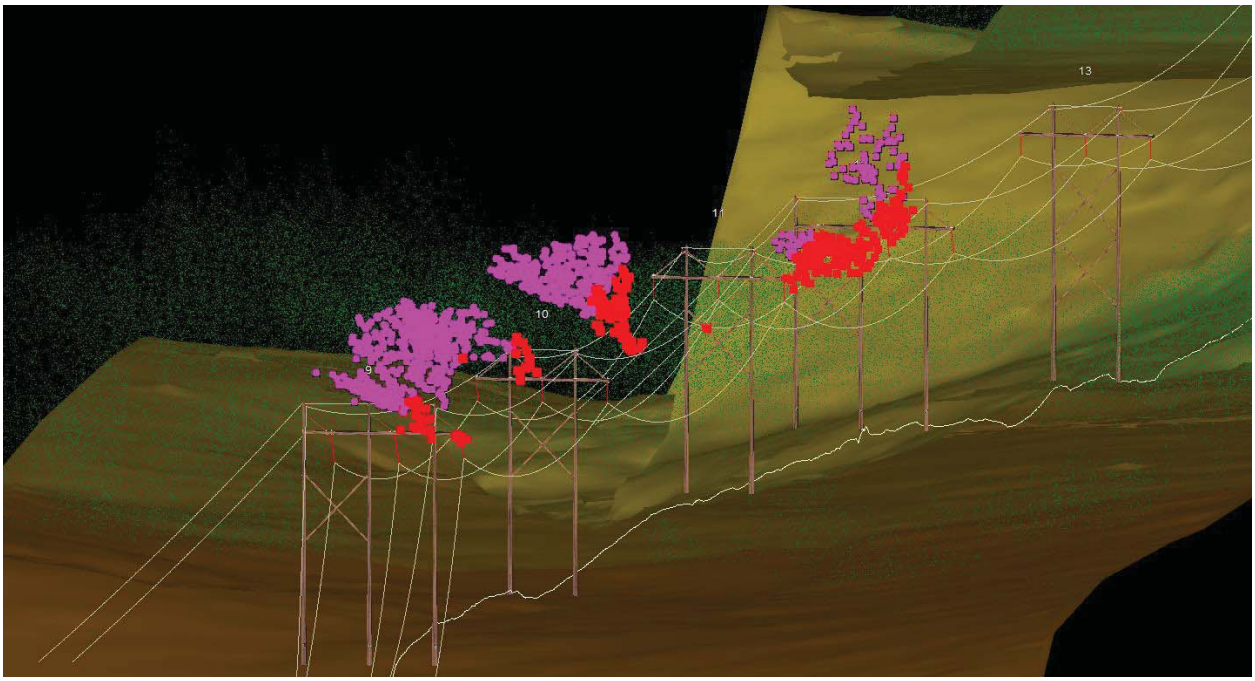
The fire risk areas which can be evaluated and identified in PLS-CADD include:

- Distance of overhead wires from vegetation and other areas of concern
- Identification of trees that could potentially fall into or close to the overhead wires
- Identification of vegetation and debris within a prescribed distance from the structure

PLS-CADD has the ability to calculate clearances to vegetation and other surveyed objects for up to 200 weather cases (combinations of wind, ice and wire temperature). Clearances are automatically calculated to wires in their blown-out position with wind blowing from the left and right directions and also considering the arc through which the wire swings between these blown-out positions.

Checks can be performed for grow-in violations along with falling tree violations. Grow-in violations are identified when vegetation survey points do not meet the user specified horizontal and vertical clearance requirements, which may include components for flashover or minimum approach distance, buffers for survey accuracy and allowances of vegetation growth. Falling tree violations assumes trees will pivot about a root ball at the base of the tree. The size of the root ball is calculated based on user input data and a violation is indicated if the top of the tree swings within the user specified clearance distance of a wire.

Checks can be made not only to wires but also to structures themselves. This allows for the identification of vegetation or debris that lies within a user specified horizontal distance of the structures and the establishment of vegetation clear zones around structures.



[PLS-CADD model showing grow-in violations in red and falling tree violations in pink]

Structural Analysis

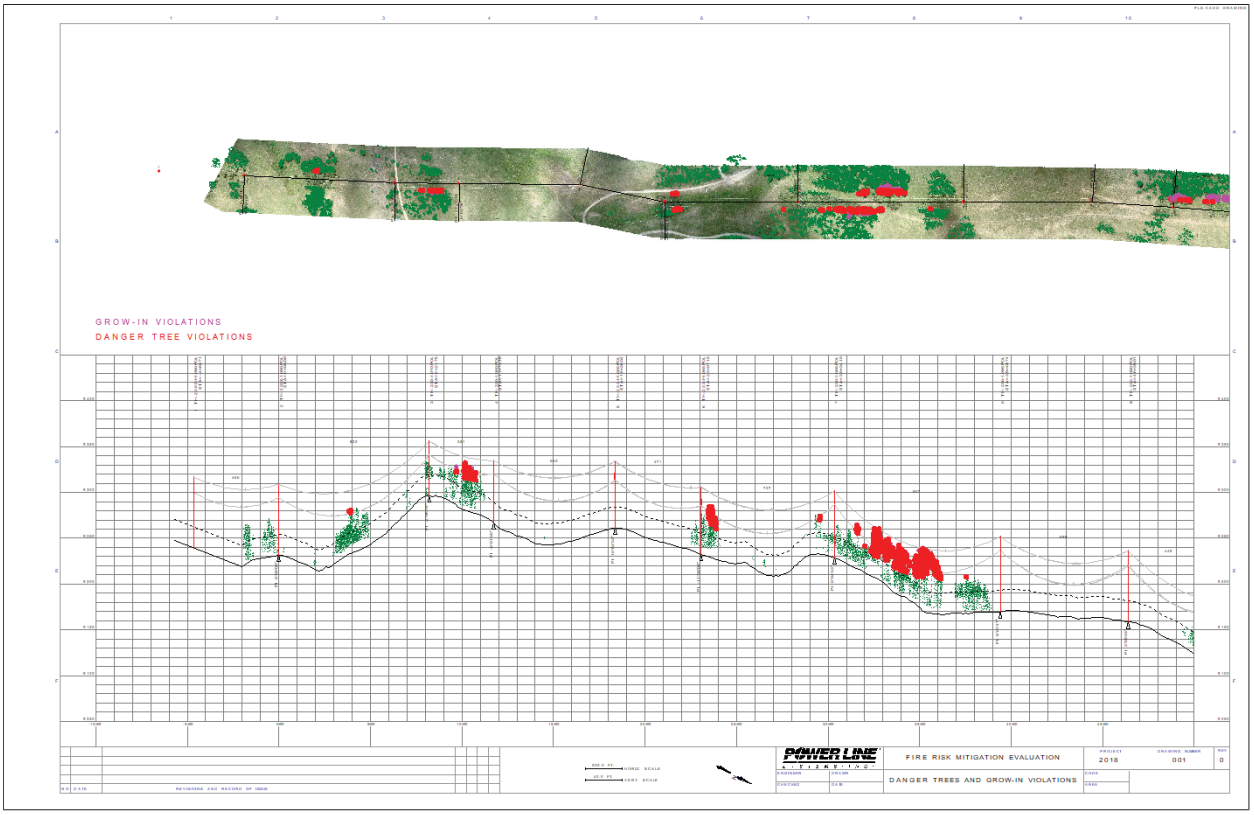
Structures which are susceptible to failure during a high wind event can also be a cause of fires. PLS has developed two structural analysis programs, PLS-POLE and TOWER, specifically for the analysis and design of overhead line structures. Many older lines, particularly wood pole lines, were originally design with "back of the envelope" methods or standard spotting templates and tables. Little or no structural analysis was performed. As the years have passed, many lines have also undergone modifications or additions of new wires or circuits, often without any additional structural analysis. In addition, new and enhanced design standards are available along with modern day modeling techniques that which can used to more accurately assess the structural capacity of poles and towers.

Utilities have been utilizing aerial inspections of their overhead lines for many years. With the continued development of high-resolution cameras and drone technology, more detailed and up-close inspections of structures are possible. When this information is used in conjunction with a structural analysis, a detailed assessment of the risk of structure failure can be made.

Documentation of Results

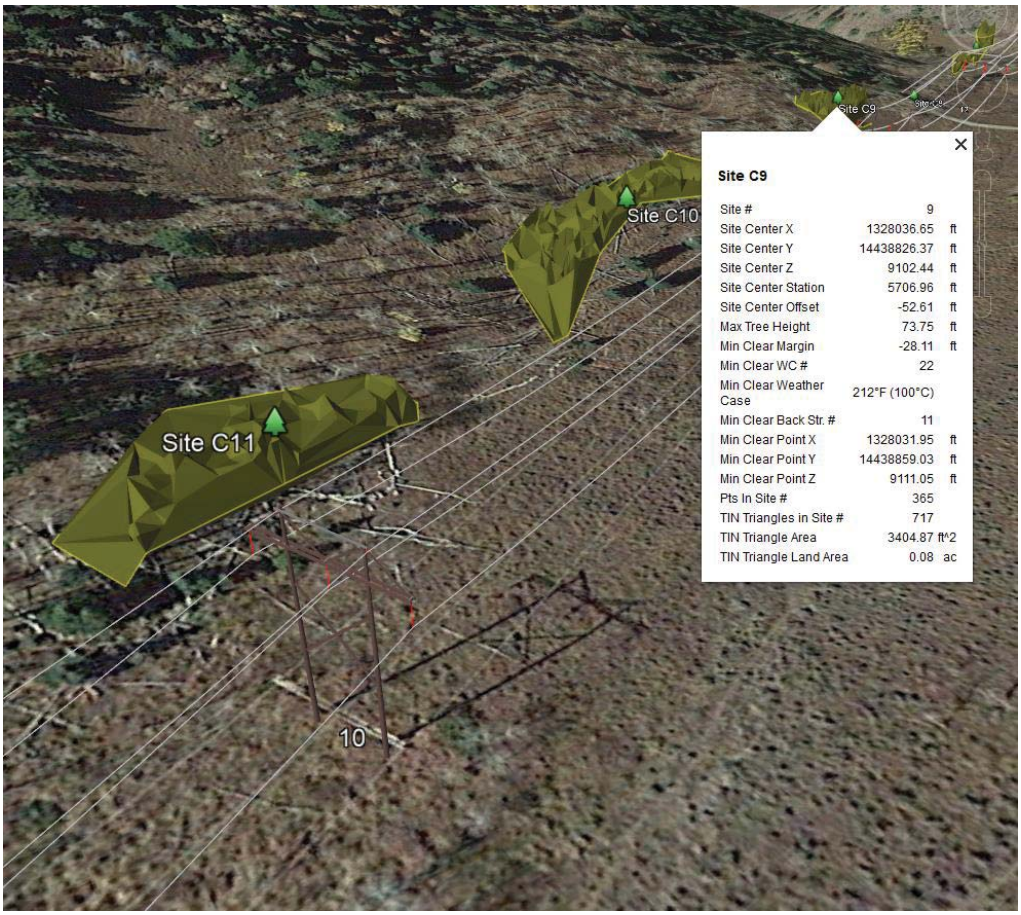
Once the analysis of the line clearances is complete, the documentation and identification of the fire risk areas can be presented in several ways. Plan and profile type drawings can easily be produced from PLS-CADD with risk areas clearly identified. Locations of grow-in and danger tree violations can be identified by unique color-coded symbols on the drawings. This provides

clearing crews precise locations where clearing needs to take place, which is more accurate, economical and environmentally friendly than wide area clearing efforts.



[PLS-CADD plan & profile drawing showing grow-in and falling tree violations]

Multiple violations can be grouped by PLS-CADD into work sites. The work site represents a single area where clearing work needs to be performed and can be used to create efficient work packages for field crews. Work sites can be displayed on the drawings and can also be exported as a KML file for viewing in Google Earth or as a SHP file for viewing in GIS or graphics software.



[Clearance work sites displayed in Google Earth]

PLS-CADD is an extremely powerful and multi-dimensional tool used for analysis and design of overhead transmission and distribution lines. When line models are developed using LiDAR survey data, users are able to utilize sophisticated vegetation management features to accurately determine the clearances of vegetation to the overhead line wires and supporting structures. Clearances to vegetation are a critical step in evaluating the wildfire risk of overhead lines and determining actions to mitigate those risks.